

## Background

- ASTM D 7566 (2009)
  - Fischer-Tropsch approved for commercial use as a blend, up to 50% (by volume)
  - Minimum 8% aromatics (by volume)
  - Minimum JFTOT of 325C
- FT fuel is known to have significantly lower particulate matter combustion emissions
- Previous research showed that Fischer-Tropsch fuel has a significantly higher break point temperature than conventional fuel

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## Motivation for Project



1. ASTM 7566 requires maximum 0.5 mass % Aromatics for hydro processed Synthetic Paraffinic Kerosene
  - Why was this maximum set?
  - What can we learn about Aromatics in regard to thermal stability?

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2. Aromatics known to improve seal-swell characteristics [1]

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## Alternative Aviation Fuel Experiment - AAFEX



**Location:** NASA Dryden Aircraft Operation Facility

**Dates:** January 20 – February 3, 2009

**Sponsors:** NASA, Air Force, EPA, FAA

**Aircraft:** DC-8 with CFM56-2 engines

**Fuels:**  
1--Standard JP-8  
2-- Fischer-Tropsch Fuel from Natural Gas (FT1)  
3--50/50 JP-8/FT1 blend  
4-- Fischer-Tropsch fuel from Coal (FT2)  
5--50/50 JP-8/FT2 blend

**Runtime:** ~35 hours total



*Leaks vanished as soon as aromatic-containing fuel introduced*

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2. Aromatics known to improve seal-swell characteristics [1]
  - How to increase aromatic content in F-T to solve seal swell problems:
    - Blend F-T fuel with conventional fuel
    - Add synthesized aromatic solution
  - If aromatics are added, will this affect thermal stability?

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  - How to increase aromatic content in F-T to solve seal swell problems:
    - Blend F-T fuel with conventional fuel
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3. Aromatics increase engine particulate emissions [1]
  - AFRL -particulate emissions increased with molecular weight and concentration
  - Attributed to increased soot precursors in aromatics
  - Does this mean the presence of aromatics will affect thermal stability?

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## Aromatic Blend Solution & Fuel Blending

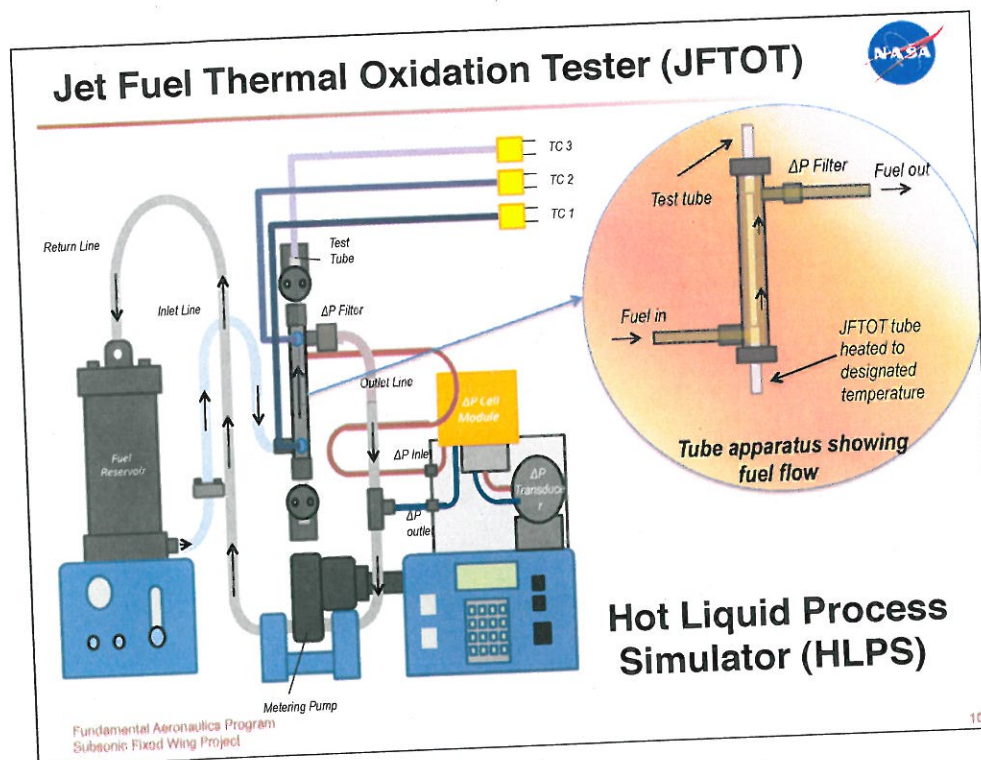
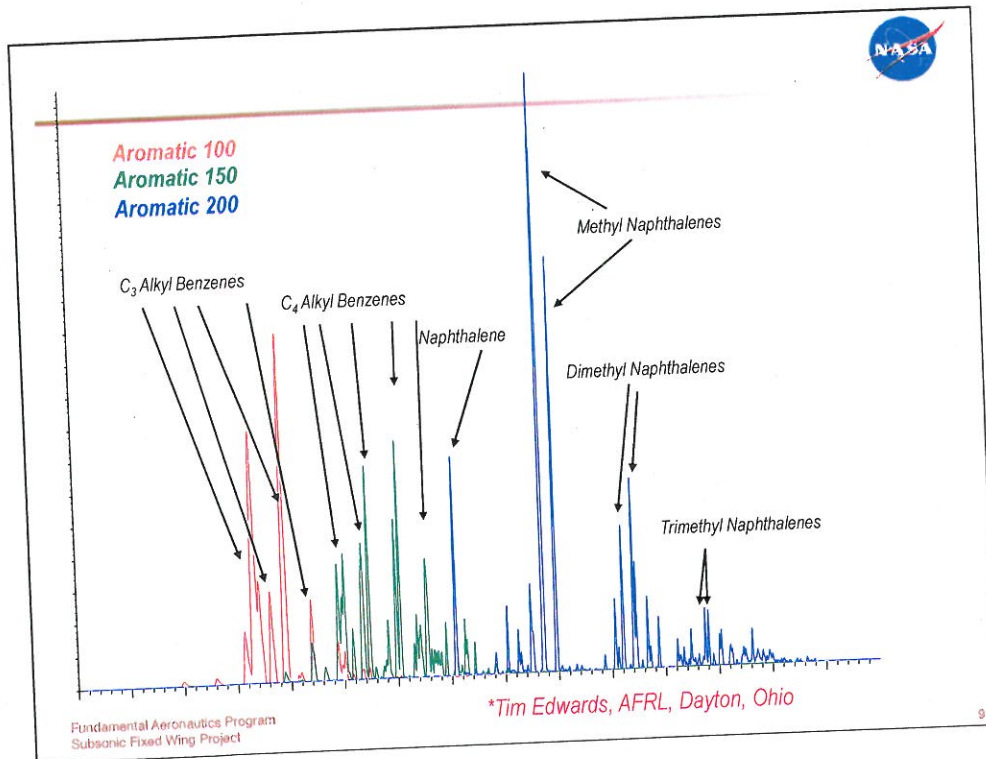


- Blend ratios determined to be best representation of jet fuel's aromatic composition
  - 30% Aromatic 100 (POSF 6867)
  - 60% Aromatic 150 (5.2 gallons - 4776, 18.8 gallons 6870)
  - 10% Aromatic 200 (POSF 4777)
- ***\*Blended by volume at Air Force Research Laboratory\****
- ***All Aromatic Solutions are available commercially***
- Fuel chosen was manufactured by Rentech
  - Gas to Liquid F-T fuel
  - Colorado pilot plant
  - Natural gas feedstock
- ***All fuel was blended with solution by volume***

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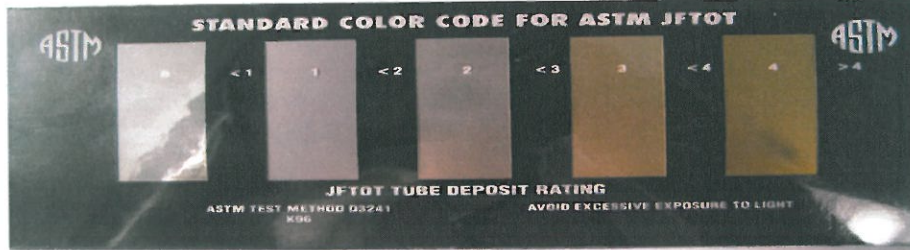
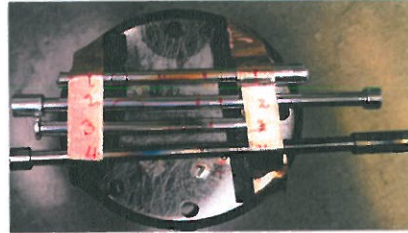




## Data Collection & Analysis



- Evaluation of fuel:
  - Visual tube rating: Fail >3 on ASTM Color Standard
  - Differential pressure fails >25 mmHg
- Fuel breakpoint determined 5°C increments



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## Test Matrix

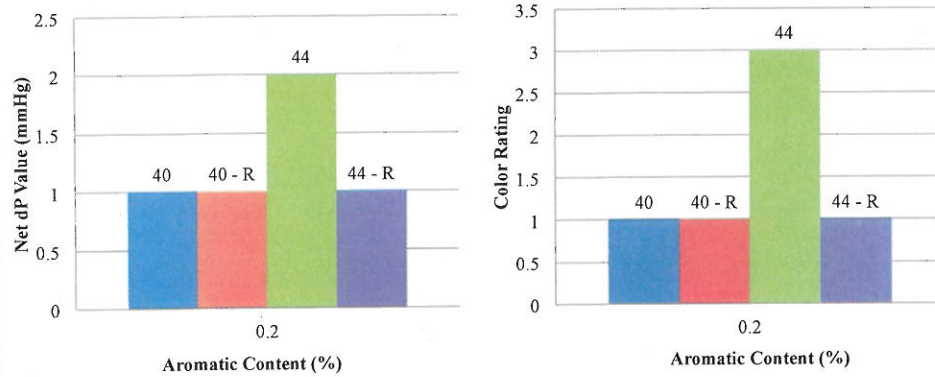


- Neat Rentech Fuel (0.2% Aromatics by volume)
- Neat Rentech Fuel (1.6% Aromatics by volume)
- Rentech Fuel with added aromatic solution
- Rentech with 10% total aromatics break point temperature determination

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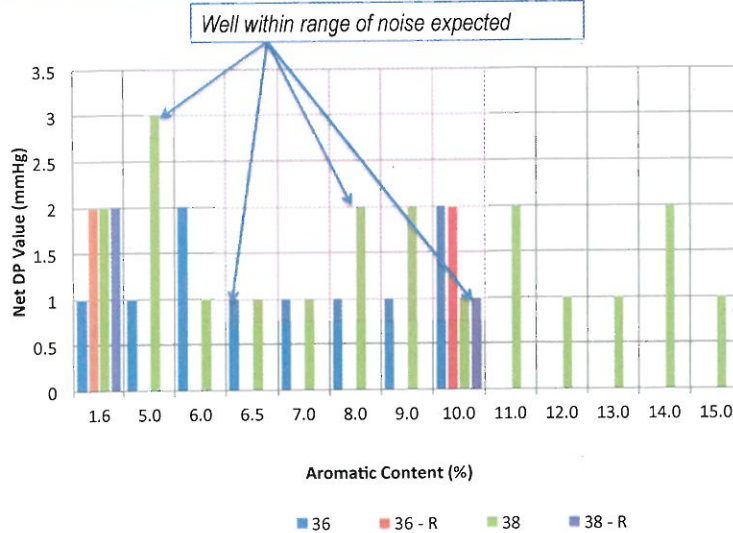
## JFTOT Results @ 380°C for 0.2% Aromatics



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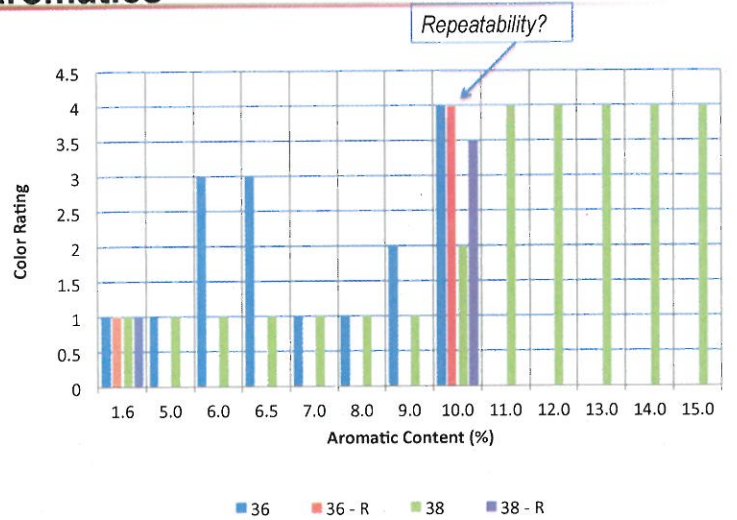
## JFTOT Results @ 380°C with Increasing Aromatics



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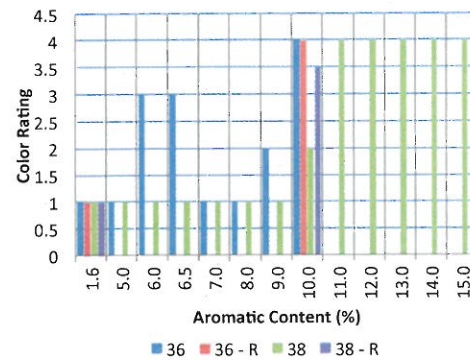
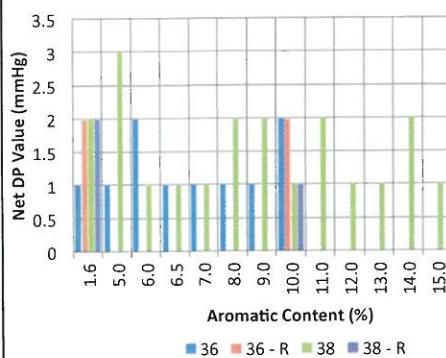
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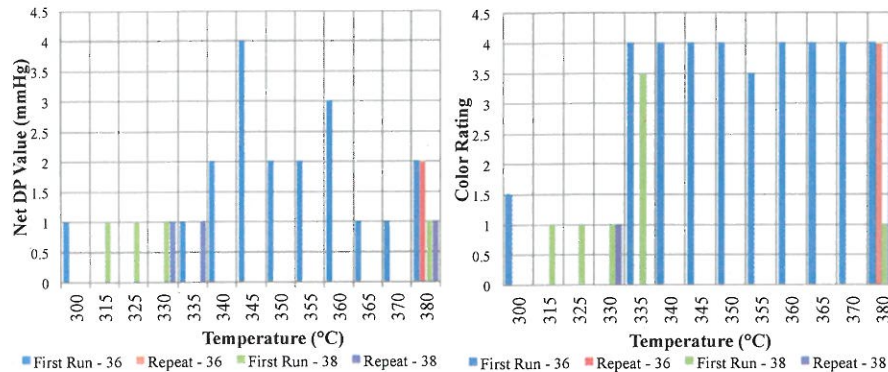


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## Breakpoint Results for 10% Aromatics



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## Conclusions & Future Work



- Aromatics affect only the tube color result in JFTOT analysis
- Initial results indicate no affect on thermal stability at up to 10% aromatics (by volume)
- Further research needs to be completed to determine if tube color correlates to more deposition on tube surface
- Run JFTOT @ 380°C on pure Aromatic Solution
- Collect data to determine repeatability
- Validate deposition through use of ellipsometer

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## Ellipsometer



- Optical method to determine thin film thicknesses
- Polarized light reflects off of surfaces
- Changes in polarization allow calculation to determine material properties (refractive index)
- Very accurate <1 nm resolution
- Standard instrumentation utilized in semiconductor industry with application flexibility



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